# Space Weather Technical Forecast

Issued on Thursday, 02 February 2023 at 01:09 Local

**This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales**

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**Space Weather Forecast Headline: Slight chance of M-flares.**

**Analysis of Space Weather Activity over past 24 hours**

**Solar Activity:** Low, with several low-level C-class flares. Peak flare was C5.8 from AR3204 Cai/Beta at 01/2248 UTC. This is a small region near the northwest limb that will soon rotate off the disc. There are a total of five sunspot regions visible, with the only other notable region being AR3207 Dsi/Beta in the southeast. While magnetically simple, this has exhibited some slow growth. No Earth-directed CMEs have been observed on available imagery, however there are a large number of filaments on the disc which will need to be monitored for any eruption.

**Solar Wind / Geomagnetic Activity:** Solar winds likely show Earth exiting from a HSS (from CH72) before transitioning into further fast winds, likely from CH73. This potentially also included a weak passing transient feature. The speed, as observed by ACE and DSCOVR at L1 eased from 450 km/s at first to background of 350 km/s at 01/0800 UTC. This was followed by a small jump to 370 km/s around 01/1540 UTC followed by a more gradual rise to around 440 km/s by 01/2000 UTC. This was accompanied by a gradual increase in density from below average to average, and then briefly jumped above average at around 20 ppcc between 01/1542-1750 UTC. Density then dropped to previous values, persisting at average thereafter. The total IMF strength, Bt, was generally weak, but erratically increased from 01/1544 UTC to end the day at moderate levels of 8-10nT. The north-south component, Bz, briefly reached a southward peak of -10nT at 01/1756 UTC, before becoming persistently negative between -2nT and -6 nT from 01/2000 UTC. The Phi angle remained negative (towards the Sun) throughout. Geomagnetic activity was Quiet to Unsettled (Kp 0-3)

**Energetic Particles / Solar Radiation:** The high energy proton flux (greater than 10 MeV) as measured at GOES-16 has been at background levels throughout. High energy electron flux (greater than 2MeV) measured by GOES-16 was at background to moderate levels. The associated 24 hour electron fluence slowly increased, reaching 8.62e6 integrated pfu by 02/0000 UTC.

**Four-Day Space Weather Forecast Summary**

**Solar Activity:** Low activity is forecast with the sunspots on the visible disc currently small and relatively simple. There is a very slight chance of M-class flares.

**Solar Wind / Geomagnetic Activity:** There are no Earth-directed CMEs, although a slight glance cannot be ruled out from a CME later on day 2 (3rd), although this will likely miss. Current slightly elevated winds may become elevated for a time day 1 (2nd), due to ongoing effects of the high speed stream from CH73/. Otherwise solar winds are expected to ease through the period, before the next CIR arrival ahead of CH74, likely later day 4 (5th) or just beyond the forecast period. Geomagnetic activity is expected to be mainly Quiet to Unsettled with a chance of Active intervals. There is a slight chance of G1/Minor Storms, mainly day 1 (2nd) and day 4 (5th).

**Energetic Particles / Solar Radiation:** The high energy (greater than 10 MeV) proton flux observed by GOES16 is expected to remain at background levels. Electron flux is expected to

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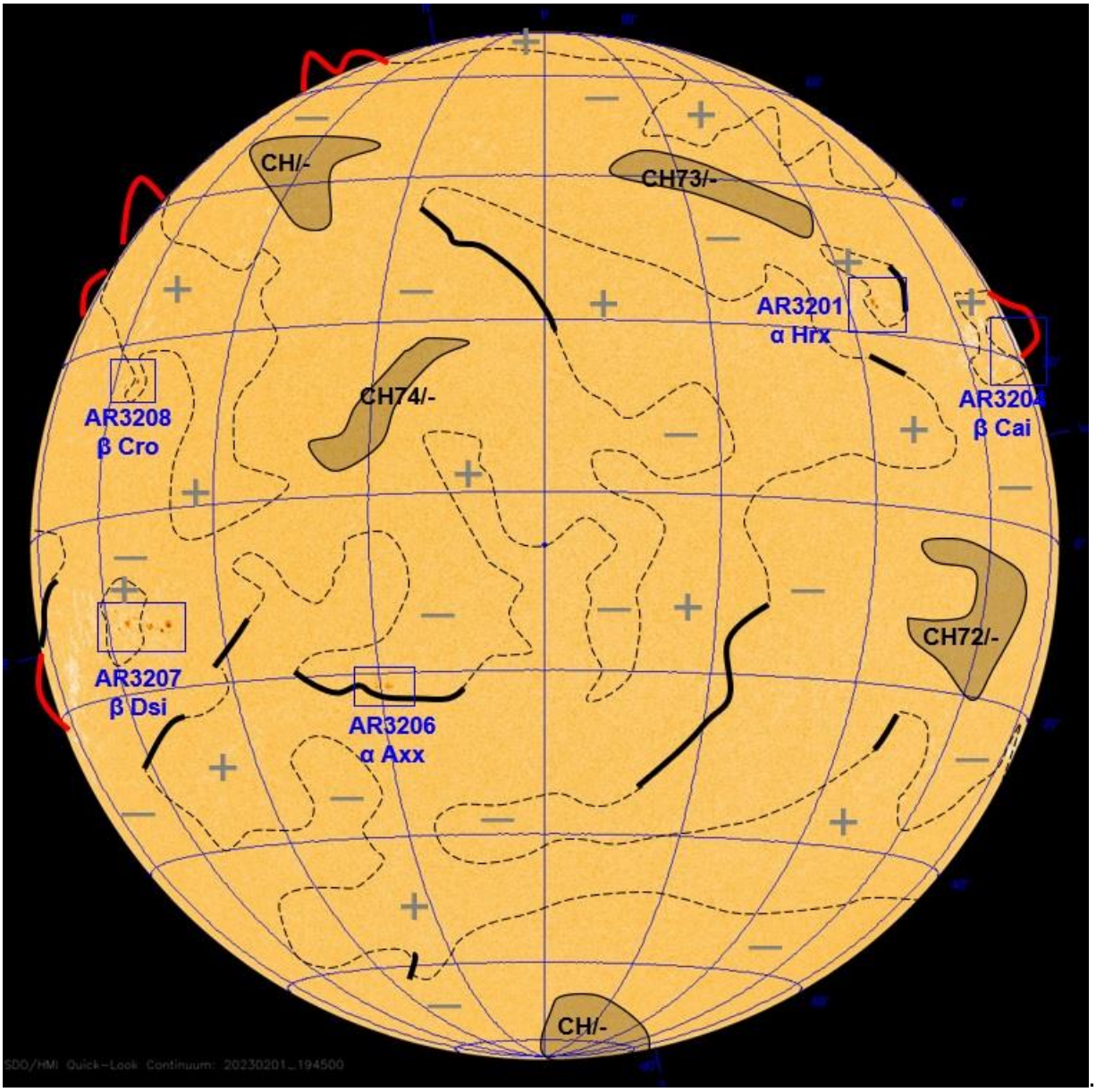
be at background or moderate levels. Electron fluence is expected to remain below the Active (1e8 integrated pfu) threshold.

**Figure 1. Solar Analysis Valid 01/2000 UTC.**




**Key:** Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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## Geomagnetic Storms:

There are no Earth-directed CMEs, however a CME that is expected to pass north and ahead of Earth may glance later on the 3rd. However, confidence is very low with the analysis of this feature.

Recent enhancements observed in the geospace environment are likely due to some interaction with the passing fast wind of CH73, in the north disc, perhaps coupled with a weak passing transient. Solar winds are likely to remain rather variable though the period, although there is a chance of reaching elevated speeds of around 500 km/s on day 1 (2nd) with the ongoing fast wind, before a general easing trend occurs.

Enlil winds indicate a potential further enhancement on day 3 (4th), but is likely due to an over-estimation of the size of CH74 in the east disc, with the following enhancement indicated in the model not expected until the end of the period, later on day 4 (5th),

Geomagnetic activity is expected to be mainly Quiet to Unsettled throughout, with a chance of Active intervals. There is slight chance of G1/Minor Storms throughout. On day 1 (2nd) this is due to ongoing fast wind effect. On day 2 and day 3 (3rd or 4th) there is the potential glancing CME before any CIR arrival likely occurs ahead of CH74 HSS later on day 4 (5th) or just beyond this forecast period.

| Geo-Magnetic Storm<br>Probability (Exceedance) | Level | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC)<br>(%) | Day 2 (00-24 UTC)<br>(%) | Day 3 (00-24 UTC)<br>(%) | Day 4 (00-24 UTC)<br>(%) |
|---|---|---|---|---|---|---|
| **Minor or Moderate** | **G1 to G2** | No | 10 | 5 | 5 | 20 |
| **Strong** | **G3** | No | 1 | 1 | 1 | 1 |
| **Severe** | **G4** | No | 1 | 1 | 1 | 1 |
| **Extreme** | **G5** | No | 1 | 1 | 1 | 1 |

## Geomagnetic Activity - Earthbound Coronal Mass Ejections

| Date/time 21.5R (UTC) | Halo: Full or Partial | Source | Source Location | Estimated Speed | Estimated Arrival Time | Comments |
|---|---|---|---|---|---|---|
| 31/0416 | Partial | Filament | NW | 350 km/s | Missing on the 3rd | Likely missing, but glancing blow possible. |

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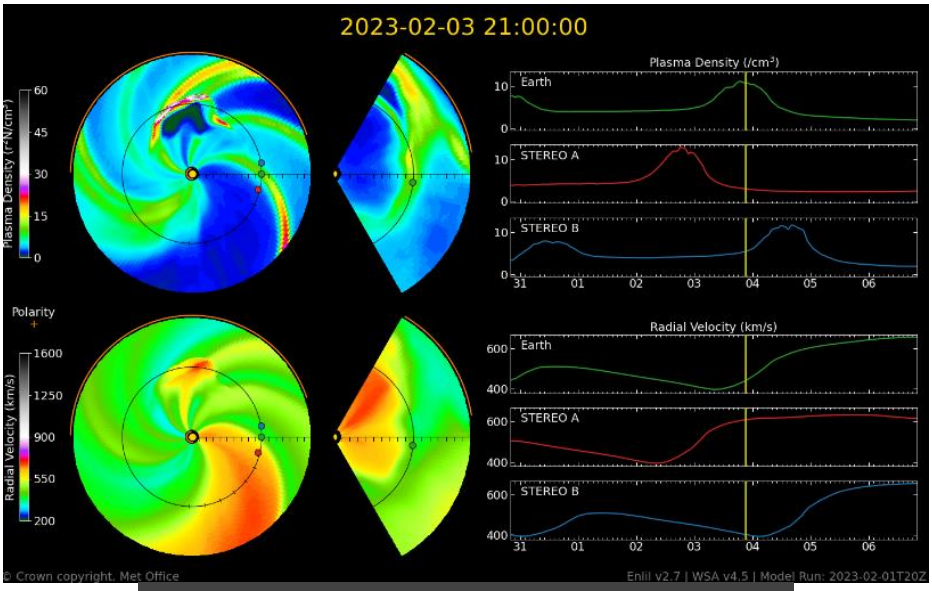
**Figure 2a: ENLIL and ensemble**



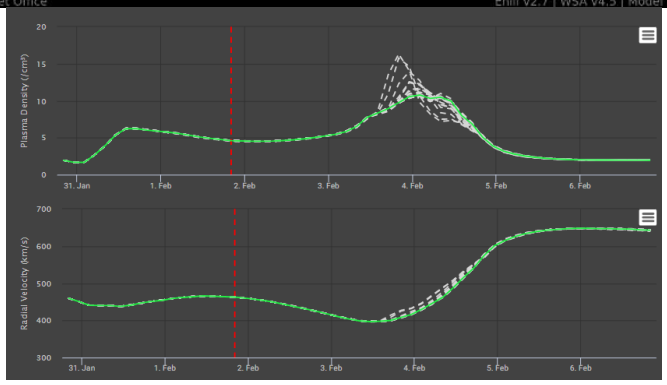
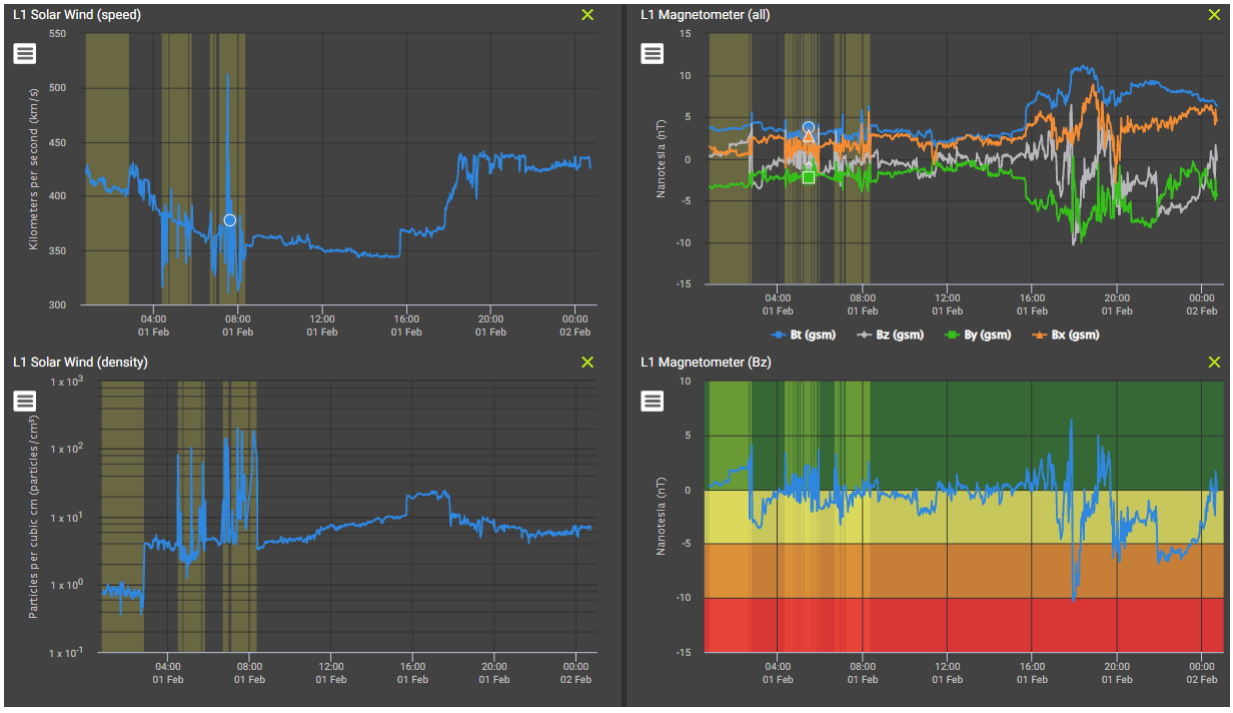




**Figure 2b: Solar winds on 1st Feb**

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## Radio Blackouts - X-Ray Flares:

There are five sunspot regions on the visible disc, however these are all small and magnetically simple. The most notable region is AR3207 in the southeast which is in the southeast disc, and has been showing some slow growth in the last 24 hours. Activity is expected to remain Low with only a slight chance of increasing to Moderate with any M-flares that occur.

STEREO A euvi imagery and the expected return of ex-AR3193 and ex-AR3184, suggest the potential for a returning regions onto the southeast within the next 48 hours. This is supported by helioseismic data, which shows the potential for regions to rotate onto the disc through the period.

| X Ray Flares | Level | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) | Day 2 (00-24 UTC) | Day 3 (00-24 UTC) | Day 4 (00-24 UTC) |
|---|---|---|---|---|---|---|
| Probability | | | (%) | (%) | (%) | (%) |
| Active | R1-R2 M Class | No | 10 | 10 | 10 | 10 |
| Very Active | R3 to R5 X Class | No | 1 | 1 | 1 | 1 |

**Figure 3a: GOES 16/18 X-ray Flux**

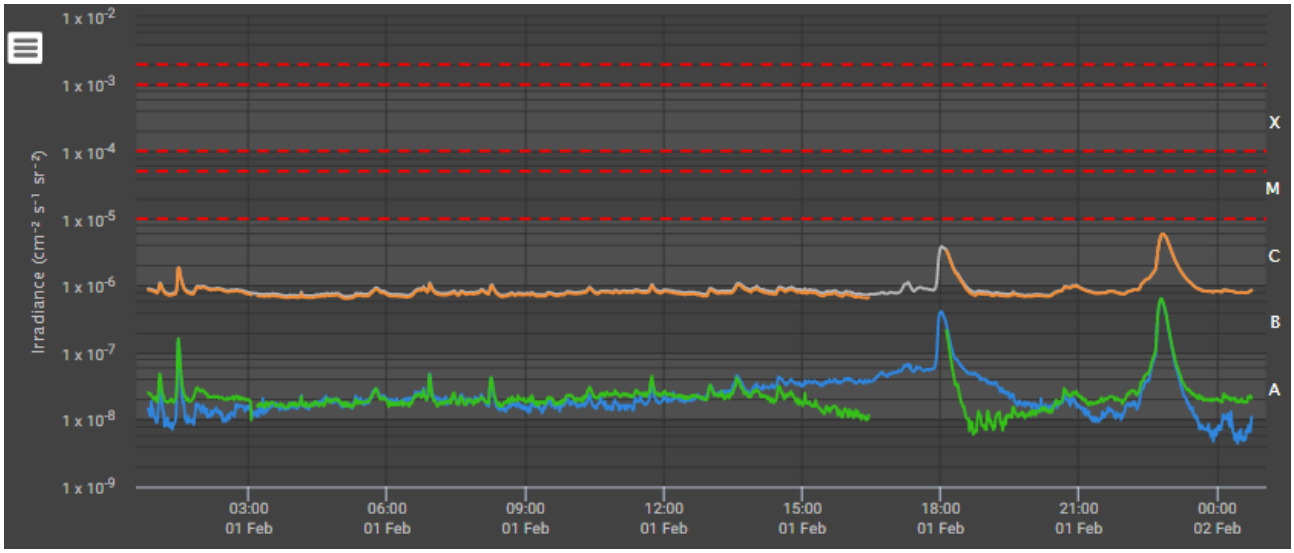


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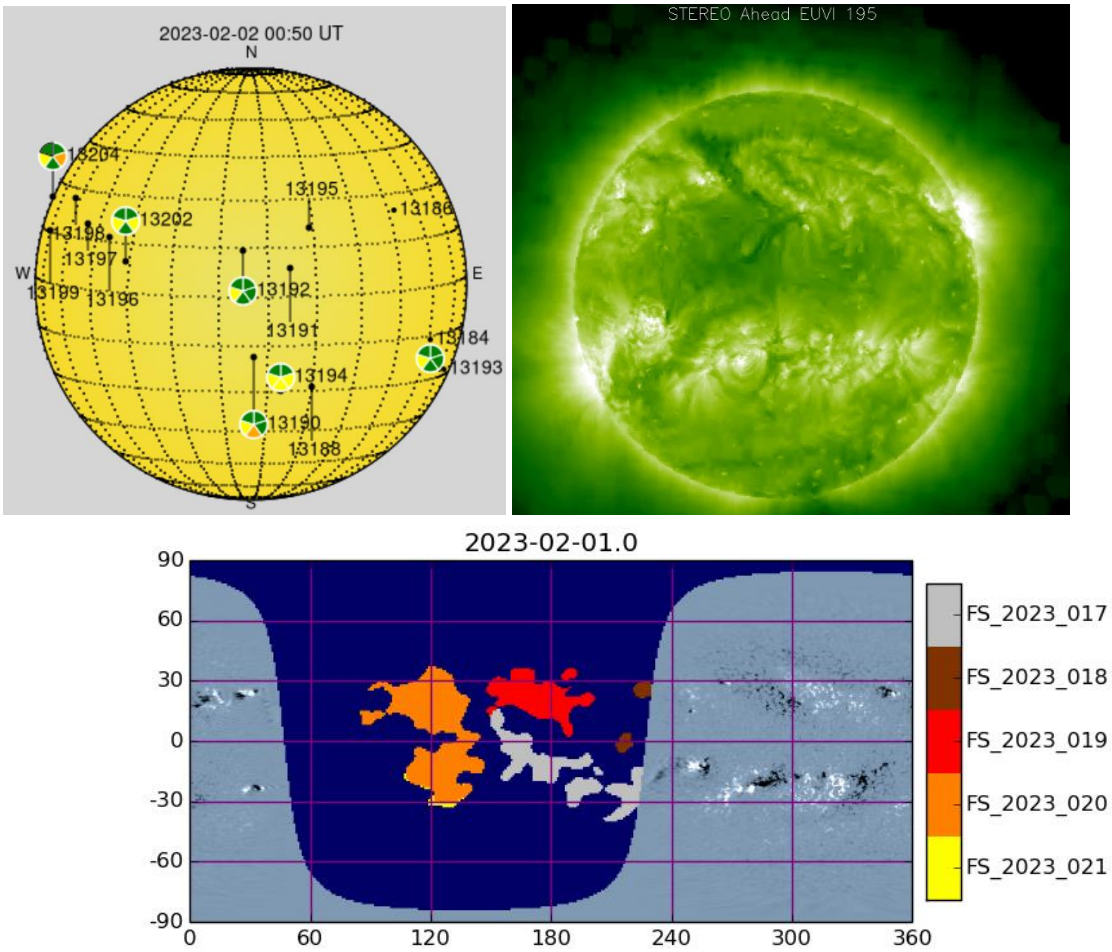
**Figure 3b: Far-side plot from raben.com (left) showing returning region. STEREO-A euvi (right), showing bright region on southeast limb. Helioseismic image (bottom) showing a number of far-side regions likely to return onto the disc.**




## Solar Radiation Storms - (High Energy Protons):

High energy (greater than 10MeV) proton flux as observed by GOES16 is currently expected to persist at background levels.

| Radiation Storms Probability (Exceedance) | Level ($cm^{-2}$ $sr^{-1}$ $s^{-1}$) | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) (%) | Day 2 (00-24 UTC) (%) | Day 3 (00-24 UTC) (%) | Day 4 (00-24 UTC) (%) |
|---|---|---|---|---|---|---|
| **Active** | **≥ S1** | No | 1 | 1 | 1 | 1 |
| **Very Active** | **≥ S3 *** | No | 1 | 1 | 1 | 1 |
| * S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$) | | | | | | |

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## High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2MeV) as observed by GOES-16 is expected to oscillate between moderate and background levels through the next four days, with only a very slight chance of rising to high on day 2 and day 3 (3rd and 4th) as solar winds ease. Although any periods of geomagnetic activity may act to suppress these values further

Electron fluence is at low levels with any rise over the next four days expected to be modest, and remaining below the Active (1e8 integrated pfu) threshold. This is supported by REFM, although this is of limited value as this has yet to account for current solar wind enhancement.

| GEO Electron Environment<br>Probability (Exceedance) | Level ($cm^{-2}$ $sr^{-1}$ $day^{-1}$) | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC)<br>(%) | Day 2 (00-24 UTC)<br>(%) | Day 3 (00-24 UTC)<br>(%) | Day 4 (00-24 UTC)<br>(%) |
|---|---|---|---|---|---|---|
| **Active** | **≥ 2 MeV ≥ $1x10^8$** | No | 1 | 10 | 10 | 10 |
| **Very Active** | **≥ 2 MeV ≥ $1x10^9$** | No | 1 | 1 | 1 | 1 |

**Figure 4: GOES-16 >2MeV Electron Flux (top) and associated fluence with REFM (bottom)**

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